The Beck group uses femtosecond non-linear spectroscopy to study photo-physical and photochemical processes in photosynthetic light-harvesting proteins, protein dynamics in redox proteins, and model systems. The current focus is on how carotenoids function in energy transfer and photoprotection mechanisms in light-harvesting proteins. A second project examines the dynamics of water molecules in the hydration shell of proteins and the coupling of these motions to protein motions. Both areas exploit advanced two-dimensional photon-echo and transient-grating spectroscopies to characterize the formation and decay of electronic coherences and structural intermediates or to discern the motion of the surrounding protein or solvent medium.

In the carotenoid project, the initial target is the peridinin–chlorophyll a protein, a light-harvesting protein from marine dinoflagellates that incorporates the carotenoid peridinin as its main light-absorbing chromophore. Energy absorbed from the mid-visible part of the solar spectrum by peridinin is transferred efficiently to chlorophyll a on the < 3 ps timescale. The project’s main goal is to understand the origin of the efficiency of this energy transfer channel. Transient-grating spectroscopy is being used to assess the formation of intermediates with charge-transfer character in the radiationless decay of the resonant $S_2 (1B_u^+)$ state and to detect double-quantum coherences. Two-dimensional spectroscopy is being used to determine how these intermediates function in energy transfer to chlorophyll a.

In the hydration shell project, we are studying how the solvent surroundings of proteins plays a role in the stability and dynamics of a folded protein. The hydration shell of proteins is a ~10 Å thick layer of polarized water molecules that interacts strongly with charges on the surface of the protein so that the motions of the water and protein are coupled. Transient grating spectroscopy and two-dimensional spectroscopy are being used in this project with electronic probes that are positioned in the hydration shell. Our findings indicate that the dynamics of water in the hydration shell is much different from that in bulk water, perhaps owing to the formation of hydrogen-bonded chains.

**Selected Publications**


